Genetic Evaluation Systems

IMPLEMENTING GENETIC EVALUATION IN THE NEW ZEALAND DEER INDUSTRY

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SUMMARY
Genetic evaluation is a tool now attracting growing use by the New Zealand deer industry. Following a pilot genetic evaluation system, a fully commercial genetic evaluation system has been implemented on an industry wide and industry supported basis. Selection of a model for implementation considered, among other criteria, the need for competition in some areas contrasted by the demand for the national good of an industry-backed single entity in other areas. Issues of operation scale in the deer industry also influenced the outcome. The result is a genetic evaluation system operating commercially and available to red deer breeders from 2005. This outcome, together with recent initiatives to develop data suitable to implement across-herd analysis, will have a significant impact on genetic progress in farmed deer. The potential for improvement of production efficiency in the deer industry is large. Objective identification and use of superior genetics combined with improved management systems will have an important role to play in aligning venison production with market demand.
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INTRODUCTION
The New Zealand farmed deer industry was established in the 1970's from a large and diverse resource of feral deer. In 30 years of deer farming significant gains have been made via importation of new deer genotypes and selection within the population of farmed deer. A breeding structure has evolved, with approximately 40 to 50 recognised breeding herds servicing a farmed deer population estimated to be 0.9 million hinds (MAF, 2005). The seedstock herds provide approximately 20 to 30% of stags required by the deer industry annually.

Until recently, most selection emphasis in seedstock herds was placed on antler traits for velvet production. This was based on approximately 50% of industry revenue being from velvet income in the early days of the industry with very high per animal returns. Also, velvet antler production is heavily dependant on genetic potential and commercial antler traits are generally highly heritable producing strong genetic responses to mass selection. The emphasis in selection for velvet is generally seen in the genetic trends calculated for most seedstock herds. Emphasis on antler traits has been further promoted as interest in producing trophy antler heads for hunting operations has grown steadily in the last decade.

However, the core nature of the deer industry has changed over time. The industry revenue split is now approximately 77% from venison, 12% velvet and 8% hides and leather and 4% co-products (Deer Industry New Zealand, 2005). This change has had some impact on breeding objectives, with growth traits receiving more emphasis in some breeding herds. Selection for traits of moderate heritability (such as growth) has brought with it a demand for more objective means of evaluating genetics rather than phenotypic performance alone. Also, more sheep and beef farmers have diversified into deer bringing to

the industry a greater appreciation of genetic tools used in other industries. These factors have generated strong support within the deer industry for developing a national genetic evaluation system, reflected in a survey conducted by DEEResearch Ltd where genetic evaluation ranked as a high research priority,.

DEVELOPMENT OF GENETIC EVALUATION FOR DEER

Pilot genetic service. In response to demand from a small number of stud herds, AgResearch offered a pilot breeding value service for deer, beginning in 1998. The service was restricted to within-herd analysis as historical breeding structures among deer seedstock herds produced only limited linkage. Traits analysed were growth and velvet, using a modular approach. The service was developed with funding from the Foundation of Research, Science and Technology, and most operating costs were recovered from breeders using the service.

From an initial 3 herds, the service grew to a point where in 2004 breeding value analyses were conducted for 15 herds (of approximately 35 recognised elite herds breeding red deer of English and European origin nationally). Several of these herds conducted breeding value analyses for the first time in 2004, while some of the herds previously using the service began twice-yearly analyses.

Commercial operation of genetic evaluation. The ready adoption of the pilot evaluation service demonstrated that the wider deer industry, and deer breeders in particular, were willing to use and pay for genetic evaluation. To establish an enduring viable genetic evaluation service for the deer industry, the pilot scheme needed to evolve to a fully commercial service with cost recovery of all operating costs. Drivers behind this development included the need for industry to have input into genetic evaluation systems, and to better utilise resources by separating development and operational functions.

Different models for the delivery of genetic evaluation services were explored. Several principles guided the choice of model. Firstly, the operation of a genetic evaluation service should be on a commercial basis, with financial support from the deer industry only for industry-good functions where market conflict or compromise exists. Secondly, while competition encourages efficiency, there are significant benefits from the development of a single national database and genetic evaluation system. A structure which combined industry-supported single entity structures for functions where a monopoly is beneficial, with potential for competition in other areas (e.g. DNA parentage services) was sought. In reality, there is no legislative ability within the industry to create a monopolistic structure or prevent others from providing competing services. A further consideration was the limitations imposed by the relatively small scale of the deer industry, which meant that setting up a full service was unlikely to be viable without taking advantage of technology and business structures developed by other industries.

The model adopted sees genetic evaluation delivered to the New Zealand deer industry via a partnership between AgResearch and Sheep Improvement Ltd (SIL), a subsidiary of Meat & Wool New Zealand. Under this partnership arrangement, SIL provide the database and operational capability, while AgResearch provides genetic evaluation software. The link between the database and genetic evaluation software is a fully automated link. Modification of the SIL database infrastructure to extend its capability to deer was funded by Deer Industry New Zealand and the New Zealand Deer Farmers Association (NZDFA) in 2004 as an industry-good function.

The service is retailed to deer breeders via the SIL bureau structure (Geenty 2000). The bureau accepts data from the breeder and uploads it via the internet to the database. When a genetic evaluation report is requested, the database sends a data file to the genetic software, which analyses the data and uploads the outputs back to the database (Newman *et al.* 2000). The report is formatted and delivered to the breeder by the bureau. The number of bureaus servicing deer breeders is currently restricted to two. This allows competition for the service while also giving sufficient volume of business to make bureaus viable. Both bureaus are also existing sheep bureaus, further reducing the overheads required for training and support.

International experience has shown the importance of industry involvement in developing genetic evaluation services (Rickards, 1997). An important feature of the service is the establishment of a "Genetic Evaluation Steering Committee" to facilitate industry input. This committee is established by Deer Industry New Zealand and the NZDFA and includes breeder and commercial farmer representatives, deer industry organisation representatives, technical expertise from AgResearch and SIL and an independent chair. The role of the committee is to determine policy and set standards with regards to genetic evaluation in the New Zealand deer industry, and provides the opportunity to take a uniform national approach to issues and avoid fragmentation. The committee's role does not extend to commercial governance of the SIL/AgResearch service. However, the committee governs the structure of genetic evaluation services and could seek to replace SIL/AgResearch with other providers if necessary. Also, additional services could be provided by other providers in the future at the discretion of the committee – an example could be the addition of other trait group modules or mate selection services.

The genetic evaluation service will also extend to providing a data link with DNA laboratories providing parentage services in deer. Deer breeders are significant users of DNA parentage technology due to the difficulties of obtaining parentage information in deer by other means. Linkage between DNA parentage and genetic evaluation databases generates significant synergies, as DNA laboratories require information on mating and calving groups which is stored on genetic evaluation databases, while genetic evaluation utilises the outcomes of DNA pedigree matches. Database linkage will result in significant savings in data handling, but will not compromise the potential for competition between DNA laboratories.

TRAITS AND MODELS

The genetic evaluation system initially offers two modules, for growth and velvet antler production. The growth module utilises data on weaning weight, autumn weight, 12 and 15 month weights and mature weights. Weaning weight and autumn weight are analysed using a direct plus maternal genetic effect model, while mature weights are analysed with a repeatability model, fitting a permanent environmental effect. Fixed effects include contemporary group, age of dam and birth date or estimated conception date fitted within herd-year-sex where data is available. Breeding values are reported for weaning weight (direct and maternal), 12-month weight and mature weight.

The velvet module utilises data on velvet antler weight (cut at the optimal time) as a 2 year old, and at older ages (3 years plus) as well as 12-month liveweight. A direct additive genetic model is fitted with a permanent environmental effect included for velvet production at older ages. Fixed effects include year of birth x contemporary group. Breeding values for mature velvet weight are reported.

FUTURE DEVELOPMENT

Future developments are likely to encompass new economically relevant traits and expantion of the number of herds participating in across-herd analysis. Modules will be refined, with genetic parameters re-estimated when more data are available and new models tested to improve the accuracy of evaluation.

Traits. The new genetic evaluation system as implemented offers modules for growth (direct and maternal) and velvet production. However, while these traits are the current priority, several other traits are commercially important and the evaluation system will be expanded to accommodate these traits as demand and use builds. It is likely that a modular approach taken to the current system will continue to be used, with sub-indices developed for trait groups. Priority areas are likely to include reproductive success, seasonality (early calving), carcass traits and temperament. Evaluation of trophy merit may also be incorporated, as the trophy market while small is a significant and growing part of the industry. At this point of time little or nothing is known about the genetic control of many of these traits, and so new research will be required before evaluation of these traits can be considered.

Across-herd analysis. Expansion of genetic linkage to support a national across-herd genetic analysis is necessary to obtain maximum benefit from the genetic evaluation system. A major limitation has been breeding structures used in the industry, which have a low level of sire linkage between breeding herds. In the past artificial reproductive technologies were not widely used, although during the last 5 years the use of artificial insemination (AI) has increased, due principally to the development of transcervical AI techniques in red deer with high success rates. An attempt in the early nineties to progress genetic evaluation by establishing a sire referencing program failed due to competing commercial interests.

In 2003 a sire reference scheme was commenced by AgResearch at Invermay Agricultural Centre, with funding from Foundation of Research Science and Technology. The scheme facilitates the development of genetic linkage between herds and implements across-herd analysis. The first across-herd analysis of growth data occurred in December 2004 using the pilot genetic evaluation system and future data will be analysed under the new SIL/AgResearch system to assist development of a national evaluation.

While public funding has been used to support sire referencing, this is not a sustainable long-term situation, and the deer industry will need to assess whether an on-going scheme is necessary, and provide support if required. In time breeding structures are likely to evolve to provide sufficient genetic linkage without formal design. This will occur partly in response to the information from across-herd breeding values as breeders will seek to source the identified superior sires.

REFERENCES

Deer Industry New Zealand (2005) In "Deer Industry New Zealand Annual Report 2003-2004", Deer Industry New Zealand, Wellington.

Geenty, K.G. (2000) *Proc. NZ Soc. Anim. Prod.* **60**:180.

MAF (2005) In "Situation and Outlook for New Zealand Agriculture & Forestry January 2005", Ministry of Agriculture and Fisheries, Wellington.

Newman, S.A., Dodds, K.G., Clarke, J.N., Garick, D.J. and McEwan, J.C. (2000) *Proc. NZ Soc. Anim. Prod.* **60**:195.

Rickards, P.A. (1997) *Proc. Assoc. Advmt. Anim. Breed. Genet.* **12:**693.